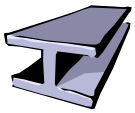
Beryllium

What Is It? Beryllium is a hard, grayish metal that occurs naturally as a component of certain rocks, soil, coal and oil, and volcanic dust. Beryllium minerals have been known since ancient times as the gemstones emerald, aquamarine, and beryl. Compounds of beryllium are either white or colorless and do not have a particular smell. Because it is an element, beryllium does not degrade nor can it be destroyed.

Symbol:	**Be**
Atomic Number: *(protons in nucleus)*	**4**
Atomic Weight:	**9**

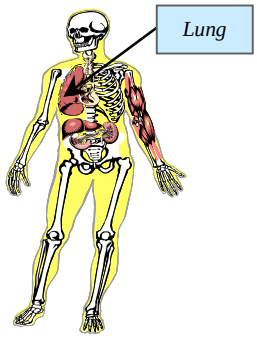
How Is It Used? Beryllium is used primarily in metal alloys (mainly with copper) that go into instruments, aircraft parts, springs, electrical connectors, and other industrial components. Beryllium is also incorporated into ceramics used in electrical insulators, microwave ovens, and rocket nozzles. Pure beryllium metal is used in missile and rocket parts, aircraft, heat shields, mirrors, and nuclear weapons.



What's in the Environment? The concentration of beryllium in the earth's crust generally ranges from 1 to 15 milligrams per kilogram (mg/kg). The average concentration of naturally occurring beryllium in soils in the United States is 0.6 parts per million (ppm) and ranges from 0.1 to 40 ppm. Typical concentrations in sandy soil are estimated to be 250 times higher than in interstitial water (the water in the pore space between the soil particles), with much higher concentration ratios in loam and clay soils. Beryllium levels in drinking water range from 0.01 to 0.7 parts per billion (ppb). In air, concentrations of beryllium are typically less than 0.0005 micrograms per cubic meter ($\mu g/m^3$). Beryllium is found in foods, with a median concentration of 22.5 µg/kg reported in 38 different foods, with concentrations ranging from less than 0.1 µg/kg to 2,200 µg/kg (in kidney beans). One cigarette contains about 0.5 to 0.7 µg beryllium, with about 5 to 10% escaping in the tobacco smoke.

Beryllium naturally enters waterways through weathering of rocks and soils that contain this metal. The major source of environmental releases from human activities is combustion of coal and fuel oil. Beryllium is also released to surface waters from industrial waste discharges, and atmospheric beryllium aerosols can be deposited on water and soil. The form released to the atmosphere is usually beryllium oxide, which eventually falls to the ground either in rain and snow or as dry particles. Beryllium oxide does not dissolve easily and does not move readily in soil or water. Hence, it is unlikely to accumulate in plants and animals. The typical ratio of the concentration of beryllium in plants to that in soil is low, estimated at 0.0015 (or 0.15%). Although chemical reactions may transform beryllium from one compound to another, beryllium itself cannot be degraded by environmental reactions.

What Happens to It in the Body? The internal fate of beryllium depends on the form that enters the body. Most beryllium compounds do not dissolve easily and are not well absorbed (less than 1%) from the gastrointestinal tract. The beryllium that is absorbed is excreted very slowly and tends to accumulate in the skeleton, liver, and kidney. Dust particles of beryllium can be inhaled and deposited in the lungs. Some deposited particles may be slowly cleared from the lungs. Although beryllium is not metabolized in the body, its soluble forms may be converted to less soluble compounds in the lungs. Beryllium absorbed into the blood is carried to tissues and organs in the body. The biological half-life of inhaled, soluble beryllium compounds is about 2 to 8 weeks.



Primary organ affected when beryllium is inhaled or ingested.

What Are the Primary Health Effects? Inhalation of beryllium can result in two types of respiratory disease, acute beryllium disease and chronic beryllium disease (also referred to as berylliosis). Both forms can be fatal. The acute disease usually occurs after exposure to high

levels of the more soluble forms of beryllium and results in symptoms ranging from inflammation of the nasal passages to severe chemical pneumonia. Chronic beryllium disease results from breathing low levels of beryllium and is a type of allergic response. The disease is characterized by the formation of nodules or granules in the lungs. There can be a long latency period (up to 25 years following exposure) prior to the onset of any symptoms. In contrast, ingesting beryllium has generally not been reported to cause effects in humans because very little beryllium is absorbed into the bloodstream. Contact dermatitis is the most common effect of beryllium on the skin, and contact with scraped or cut skin can cause rashes or ulcers. Although it is a suspected carcinogen in humans (lung cancer), scientific evidence is inconclusive. For this reason, the Environmental Protection Agency (EPA) classifies beryllium as a probable human carcinogen for inhalation.

What Is the Risk? The EPA has developed toxicity values (see box below) to estimate the risk of getting cancer or other adverse health effects as a result of inhaling or ingesting beryllium. The toxicity value for estimating the risk of getting cancer is called a slope factor (SF), and the value for the non-cancer effect is called a reference dose (RfD). An SF is an estimate of the chance that a person exposed to the chemical will get cancer from taking in one milligram beryllium per kilogram of body weight per day (mg/kg-day) for a lifetime. An RfD is an estimate of the highest dose that can be taken in every day without causing an adverse non-cancer effect. These toxicity values have been developed by studying test animals given relatively high doses over their lifetimes, then adjusting and normalizing those results to a mg/kg-day basis for humans, or directly from studies of humans exposed to beryllium in the workplace.

Chemical Toxicity Values		
Cancer Risk	**Non-Cancer Effect**	
Inhalation SF	***Oral RfD***	***Inhalation RfD***
8.4 per mg/kg-day	0.002 mg/kg-day	0.0000057 mg/kg-day

To illustrate how the RfD is applied, a 150-pound (lb) person could safely ingest 0.14 mg of beryllium or inhale 0.0004 mg of beryllium every day without expecting any adverse effects (2.2 lb = 1 kg, or 1,000 grams, or 1 million mg). In contrast to the RfD, which represents a "safe daily dose" (and so is compared to the amount an individual takes in, as a ratio), the SF is multiplied by the amount taken in to estimate the cancer risk. Using the SF, the EPA estimates that a person would have a one-in-a-million chance of developing cancer if exposed to air containing 0.004 $\mu g/m^3$ beryllium every day over a lifetime.

What Are the Current Limits for Environmental Releases and Human Exposure? To help track facility releases to the environment, the Superfund amendments that address emergency planning and community right-to-know require certain chemical releases to air, water, or land to be reported annually and entered into a nationwide Toxic Release Inventory. For all beryllium compounds, the reportable quantity is 10 lb (4.54 kg). For drinking water supplies, the EPA has established a maximum beryllium level of 4 µg/liter. For workers exposed over an 8-hour work day, the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) have established protective levels of 0.0005 and 0.002 mg of beryllium and beryllium compounds per cubic meter of air (mg/m^3), respectively. In additional, the EPA restricts industrial releases of beryllium to 10 grams in a 24-hour period or an amount that would result in atmospheric levels of 0.01 $\mu g/m^3$ averaged over a 30-day period.

Where Can I Find More Information? More information on beryllium can be found in the primary information source for this overview: the Toxicological Profile for Beryllium prepared by the Agency for Toxic Substances and Disease Registry (ATSDR). Several sources of information are available on the Internet, including the ATSDR ToxFAQS (http://www.atsdr.cdc.gov/toxfaq.html), EPA's Integrated Risk Information System Database (http://www.epa.gov/iris/subst/index.html), and the Hazardous Substances Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).